DOCUMENT RESUME

ED 207 707 PS 012 427

AUTHOR Denno, Deborah; And Others
TITLE Early Cognitive Functioning: Sex and Race Differences.
SPONS AGENCY Law Enforcement Assistance Administration (Dept. of Justice), Washington, D.C.
PUB DATE Aug 81
GRANT 78-NI-AX-0125
NOTE 44p.; Paper presented at the Annual Meeting of the American Psychological Association (89th, Los Angeles, CA, August 24-28, 1981).

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Black Youth; Cognitive Ability; *Cognitive Development; Comparative Analysis; Educational Attainment; Longitudinal Studies; Mothers; *Racial Differences; *Sex Differences; *Spatial Ability; *Verbal Ability; Whites; *Young Children

ABSTRACT

This longitudinal study was designed to investigate the nature and extent of sex differences in both verbal and spatial abilities among black and white children. Six scales of early cognitive functioning were administered at three times (at 8 months, 4 years and 7 years) to 3,013 children. Two major hypotheses were examined: (1) if cognitive development is related to maturational rate, which differs in terms of sex and race, early intelligence scores will show a sex by race interaction; and (2) if spatial abilities are the most influenced by maturational rate, this interaction will occur more strongly for spatial than for verbal abilities. Results provided only partial support for these hypotheses; a slight sex by race interaction was found at 4 and 7 years for both verbal and spatial abilities and sex by race differences were more apparent in 7-year-olds' spatial abilities relative to verbal abilities. Specifically, white males showed the highest level of intellectual performance, followed by white females, black females, and black males. However, sex differences were greater for whites than for blacks, and race differences were greater for males than for females. Findings are discussed in terms of possible maturational and environmental influences on cognitive abilities among different sex and racial groups. (Author/MP)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)
X This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

ED207707

EARLY COGNITIVE FUNCTIONING: SEX AND RACE DIFFERENCES

Deborah Denno
Center for Studies in Criminology
and Criminal Law
University of Pennsylvania
Philadelphia, Pennsylvania

Ben Meijs[1]
Institute of Criminology
University of Leiden
Leiden, The Netherlands

Israel Nachshon
Department of Criminology
Bar Ilan University
Ramat Gan, Israel

Steven Aurand
Center for Studies in Criminology
and Criminal Law
University of Pennsylvania
Philadelphia, Pennsylvania

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Deborah Denno
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

PS012427

This study was supported by grant #78-NI-AX-0125 awarded by the Law Enforcement Assistance Administration, National Institute of Justice, to Marvin E. Wolfgang, Director, Center for Studies in Criminology and Criminal Law, University of Pennsylvania. Points of view are those of the authors and do not necessarily represent the views of the U.S. Department of Justice.

[1]Now at the Center for Studies in Criminology and Criminal Law, University of Pennsylvania, Philadelphia, Pennsylvania.

EARLY COGNITIVE FUNCTIONING:
SEX AND RACE DIFFERENCES

ABSTRACT

Six scales of early cognitive functioning were administered at three times (eight months, four and seven years) to 3013 black and white, male and female children. Hypotheses addressed the nature and extent of longitudinal sex differences in cognitive abilities among racial groups varying in physical maturation. Controlling for selected socioeconomic influences, a slight sex by race interaction was found at four and seven years. Generally, white females scored somewhat lower on cognitive tests than white males, whereas black females scored equivalently or somewhat higher than black males. Test score differences among the four sex and race groups were more apparent in seven-year spatial abilities relative to verbal abilities. Findings are discussed in terms of possible maturational and environmental influences on cognitive abilities among different sex and race groups.

Substantial evidence points to sex differences in specific types of cognitive abilities (Anastasi, 1958; Benbow and Stanley, 1980; Maccoby and Jacklin, 1974; McGlone, 1980). Females score somewhat higher than males on certain verbal tasks, such as articulation and grammar; in contrast, males score considerably higher than females on spatial tasks, such as disembedding figures and mental rotation (Maccoby and Jacklin, 1974; McGlone, 1980). A spatial advantage for males increases after puberty and persists through adulthood (Harris, 1978; McGuinness and Pribram, 1979), despite no consistent sign of sex differences in general intelligence (Wechsler, 1944, 1949).

The evidence for sex differences in cognitive functioning is not disputed; however, its determinants are. The controversy focuses on the extent to which intellectual variation is explained in terms of biological or environmental factors. Research on the etiology of cognitive differences reveals a complex interaction of social, genetic, hormonal and neuroanatomical influences (Burstein, et al., 1980; Waber, 1976, 1977). Spatial abilities are a major focus of research because they demonstrate the most consistent sex differences among cognitive measures (Harris, 1978).

According to Sherman (1978), sex differences in cognition result from socioculturally determined sex role pressure, whereby boys, but not girls, are encouraged to perform spatial tasks (e.g., block building) and consequently develop more advanced spatial skills. Serpell (1979) emphasizes boys' greater experiences with spatial and perceptual tasks, independent of role socialization. Generally, theories supporting differential socialization and experiences are widely accepted (Hetherington, 1965; Maccoby and

Jacklin, 1974; Mussen, 1969). However, concrete evidence for these theories is limited, and predominantly inferential (Burstein, et al., 1980).

Evidence of biological correlates of spatial advancement in males (e.g., a sex-linked recessive inheritance) substantiates arguments that, relative to verbal abilities, spatial abilities are more genetically determined (Bock and Kolakowski, 1973). However, methodological difficulties, such as small sample sizes, and confounding environmental influences, throw doubt on many studies of the heritability of sex differences in cognition (Burstein, et al., 1980; Kamin, 1974; McGee, 1979; Park et al., 1978). Similarly, research relating hormones to cognitive functioning—specifically, the neurochemical effects of androgens and estrogens on verbal and spatial performance (e.g., Broverman et al., 1968)—has been criticized on both theoretical and methodological grounds (Burstein et al., 1980). Although results from studies of clinical populations strongly suggest the influence of hormones on cognition (e.g., Money et al., 1968), the relationships with specific abilities are not clear, particularly in children. According to Waber (1976, 1977), no sex differences in cognitive functioning are apparent when boys and girls are matched for rate of sexual maturation, rather than for chronological age.

Evidence of anatomical and functional sex differences in cerebral lateralization (McGlone, 1980) seems to provide more convincing explanations for cognitive variation. In most individuals, the left cerebral hemisphere specializes in processing verbal stimuli, whereas the right hemisphere specializes in processing spatial stimuli (Bogen, 1969). Recently, consistent sex differences in hemispheric specialization have been found (Bryden, 1979; Harshman, 1976; Kimura, 1969; Levy and Gur, 1980; Levy and Reid, 1976;

McGuinness and Pribram, 1979). Generally, males are more asymmetric in cognitive abilities, and demonstrate hemispheric specialization in spatial skills relative to females, who are more bilateral in verbal abilities, and show competing verbal and spatial lateralized functions (Harris, 1978). Thus, males perform better than females on spatial tasks, such as the performance subtests of the Wechsler Intelligence Scale for Adults (WAIS); in contrast, females perform better than males on verbal tasks, such as the verbal subtests of the WAIS (Maccoby and Jacklin, 1974).

The processes underlying the development of sex differences in cognition emerge from results of hemispheric research on children. In her study of verbal and spatial performance among children aged 5 to 8 years, Levy (1976) provides data which indicate that the left hemisphere matures earlier than the right in girls, while the right hemisphere matures earlier than the left in boys. Both Levy (1976) and Harris (1978) suggest that, relative to girls, boys' lag in verbal development facilitates the acquisition of spatial skills, particularly in combination with differential sex role socialization of skills. The importance of social factors is demonstrated by a number of recent studies (Nachshon, 1981; TenHouten, 1980; Thompson, 1979) showing sociocultural and racial influences on lateralization. According to TenHouten (1980), for example, blacks are more right hemisphere-dominant than whites. Moreover, females are more right hemisphere-dominant than males among blacks and lower-to-middle socioeconomic status whites, whereas the reverse trend is evident among higher socioeconomic status whites.

Attempts to decipher the nature of biological and sociocultural interactions in cognitive abilities focus on comparisons of sex differences

within various ethnic or racial groups. If, in fact, sex differences in cognition result solely from sociocultural influences, the magnitude of these differences should vary according to the culture. However, evidence of sex differences across ethnic and race groups does not consistently support this hypothesis.

Jensen (1971) concludes that the general intelligence scores of females are higher than the scores of males among blacks relative to whites, presumably because of differential genetic aptitudes. However, Strauch (1977) notes inconsistencies in the research cited by Jensen and, along with others (e.g., Humphreys et al., 1976), could find no evidence of Jensen's proposed sex by race interaction.

Schratz (1978) provides a sociocultural interpretation of her finding that black females score higher on spatial tasks than black males, whereas white females score lower on spatial tasks than white males. However, Jahoda (1980) reports similar magnitudes of better spatial performance for males than for females among black and white children in two cultures which differ considerably in early sex role socialization and opportunities for spatially oriented activities. Jahoda (1980) suggests an interactionist (biology-environment) interpretation of sex differences in spatial performance, rejecting both purely biological or environmental approaches.

Recent investigations of the biology-environment interaction in cognitive functioning suggest that social and environmental factors augment, or perhaps create, initial biological sex differences which are then environmentally perpetuated (Ray and Newcombe, 1980). The recurrent finding that sex differences in functional brain asymmetry are weak prior to puberty suggests that

maturational factors, possibly in interaction with environmental ones, may influence the degree of brain asymmetry (McGlone, 1979). The effect of pubertal and postpubertal sex hormone level on lateralization and cognitive skills has been extensively investigated, although with no definite conclusions (Hoyenga and Hoyenga, 1979). However, Waber (1976, 1977) and others (e.g., Nottebohm, 1980) argue that sex differences in cognitive abilities reflect differences in hemispheric organization, which in turn are related to differential rates of physical maturation. Late-maturing adolescents perform better on tests of spatial than verbal abilities, and are more lateralized for speech, than early-maturing adolescents who show the opposite pattern. Thus, females, who generally mature earlier than males, are relatively less lateralized (Waber, 1976, 1977).

Evidence also exists that males and females mature physically at different rates among different ethnic groups. For example, Malina (1970) supports Todd's (1931) earlier finding of negligible differences in skeletal maturation, an excellent indicator of physical growth, among black and white preschool and adolescent males, but advanced skeletal maturation of black in comparison to white females, particularly in ages approaching adolescence (six to nine years). Generally, females of both races mature quicker than males; these findings hold across different socioeconomic levels. As yet, however, no study has examined sex differences in both verbal and spatial abilities among different racial groups varying in maturational rate.

The present study is designed to investigate the nature and extent of longitudinal sex differences in both verbal and spatial abilities among black and white children drawn from a sample similar to that studied by

Malina (see Eveleth et al., 1979). Two major hypotheses are examined: If cognitive development is related to maturational rate, which differs in terms of sex and race, early intelligence scores should show a sex by race interaction. If spatial abilities are the most influenced by maturational rate (as Waber suggests), they should show this interaction more strongly than verbal abilities.

METHOD

Subjects

The subjects in this study were selected from a sample of 9236 children whose mothers participated in the Philadelphia Collaborative Perinatal Project (CPP) at Pennsylvania Hospital between 1959 and 1966. Pennsylvania Hospital was one of twelve medical centers selected by the National Institute of Neurological Diseases and Stroke (NINDS) in a nationwide study of genetic, biological and environmental influences upon child development. Thus, the total sample reflects, in part, the characteristics of children born to a self-selected group of women who were interested in receiving inexpensive maternity care provided by a public clinic.

Only children who adequately completed the eight-month, four- and seven-year psychological examinations within the prescribed age ranges were included in the present study. Of the 3013 children who met these criteria, the majority (n=2836; 94.12%) were black; the remainder (n=177; 5.88%) were white. Males and females were nearly equally represented in both groups (males comprised 49.15% and 47.46% of the black and white groups, respectively).

In an examination of the total population of CPP women, Myrianthopoulos and French (1968) found that the Philadelphia sample is about average in socioeconomic status for the CPP group, and is slightly lower (by one decile) than the average level for the U.S. population. Intelligence tests in general fell into the low average range for all four sex and race groups. Thus, results in this study are generalizable only to similar samples.

Tests

Six scales were used as dependent variables in the following analyses:

1. Eight Months - Bayley Scales of Mental and Motor Development

The eight-month examination included the Bayley Scales of Mental and Motor Development which were modified and standardized for use in the national CPP. Generally, the Bayley Scales are used to establish a child's current developmental status (Bayley, 1933), although recent research using the CPP data has been largely predictive (e.g., Goffeney et al., 1971). Only children who took the examination at age 8 months ± 15 days were included in analyses.

2. Four Years - Stanford-Binet Intelligence Scale

The Stanford-Binet Intelligence Scale is used in this study for assessing intellectual development among children between the ages of 30 months (the upper age limit on the Bayley Scales) and 48 months (the lower age limit on the Wechsler Intelligence Scale for Children, WISC, which was administered at seven years). A short form of the Stanford-Binet was used. Silverstein (1969) has demonstrated that the short and long forms have comparable reliability. Only children who took the examination at age 4 years ± 6 months were included in analyses.

3. Seven Years - Wechsler Intelligence Scale for Children (WISC)

In this study, three summary WISC scales were used: Verbal IQ, Performance IQ and Full Scale IQ. A short form of the WISC was administered, which comprised four of the verbal subtests (information, comprehension, vocabulary and digit span), and three of the performance subtests (picture arrangement, block design and coding). Silverstein (1967) has shown that the short and long forms of the WISC are functionally equivalent. Only children who took the examination at age 7 years ± 6 months were included in analyses.

Socioeconomic Status (SES)

Two measures of SES collected at the seven-year examination, family income and maternal education, were considered as covariates in initial analyses to control for their possible confounding effects on test scores. Of the many available SES measures (e.g., parents' occupation and education, size of household, etc.), research on the CPP has indicated that seven-year family income and maternal education are the relatively stronger correlates of intelligence test scores (Broman et al., 1975). In this study, family income also showed a relatively high correlation (r [3011] = .5, $p<.001$) with presence or absence of the father in the household, suggested in other research (e.g., Pederson et al., 1979) as influencing childhood intelligence (i.e., the father both contributes to the household income and provides a role model for the child). Because presence of the father was somewhat redundant with family income, it was considered unnecessary to include as an additional covariate in analyses.

The family income measure used in this study was derived from an index

developed by Myrianthopoulos and French (1969) for the entire CPP population, and is comparable to the U.S. Census Bureau's index for national income. Family incomes were translated into 1970 dollars (the midpoint year of the seven-year examinations) and 1980 dollars using the consumer price index for Philadelphia in order to eliminate cohort differences due to inflation. In the following analyses, both maternal education and family income were logarithmically transformed to normalize their negatively skewed distributions.

RESULTS

Influence of Socioeconomic Status and Heterogeneity of Test Score Variances

Prior to analyses of sex and race differences in cognitive functioning, two possible test score biases were examined: (1) differences in SES and (2) heterogeneity of test score variances (see Humphreys et al., 1976 and Strauch, 1977 for a discussion of these biases).

Concerning SES, Table 1 shows that families from all four sex and race groups have low average education and income. A two-way analysis of variance

INSERT TABLE 1 ABOUT HERE

(ANOVA) was performed to test the main and interaction effects of sex and race on family income and maternal education. The results indicate a significant effect of race on maternal education (F [1,3012] = 107.34; p = .0001), but a negligible effect on income (F [1,3012] = 3.26; p = .07). No significant sex effects were found. Significant two-way interactions of sex and race on both education (F [1,3012] = 4.32; p = .04) and income

(F [1,3012] = 4.73; p = .03) were apparent. Generally, white mothers had lower education levels than black mothers, although family incomes were marginally higher for whites. Families of black males and black females had similar mean scores on the education and income measures. However, families of white males tended to have higher education and income levels than families of white females.

Subsequent analyses determined, however, that the use of the two covariates of education and income was both unnecessary and inappropriate for adjusting group means: relationships between sex and race with the covariates could produce inaccurate results, since the regression adjustment might have obscured part of the main effect (Wildt and Ahtola, 1978); and covarying either family income or mother's education in our sample did not alter group mean test scores in any substantial way. Moreover, partial correlations between the six cognitive tests, controlling both for education and income, did not differ whatsoever from correlations without these controls. The major influence of the covariates appeared to be in decreasing only slightly the standard errors of the mean test scores for blacks and whites, and thus possibly altering the significance levels of statistical tests. For these reasons, the selected covariates were precluded from further analyses.

The four sex and race groups also do not show consistent differences in test score variances (Table 2). White females tend to have the largest test score variances whereas white males have the smallest; black males and black

INSERT TABLE 2 ABOUT HERE

females show less variability than white females, but more variability than white males. However, these relationships are only trends and they are not consistent across examinations. The greatest heterogeneity occurs at infancy where there are significant differences between black males and females, and between black and white males. No differences are evident at four years and significant differences occur at seven years only between white males and white females on the WISC Full Scale IQ, and between black males and black females on the WISC Performance IQ. Overall, however, test score variances are relatively homogenous. Therefore, heterogeneity of variances was not considered problematic in future analyses

Longitudinal Sex and Race Differences in Abilities

Mean score differences were analyzed by sex and race for the eight-month, four- and seven-year examinations. Multivariate analyses were conducted with and without the eight-month tests, since past research has indicated that negligible sex and race differences exist at this age (Broman et al., 1975). The WISC Full Scale IQ, a linear combination of the component verbal and performance scores, was omitted entirely from multivariate computations; its inclusion would have resulted in a matrix that was not of full rank, and thus computationally intractable.

The effects of sex and race on linear combinations of the cognitive tests were examined using a two-way multivariate analysis of variance (MANOVA). Four measures of the significance of a MANOVA are available; Wilks's lambda is the most widely used (Green, 1978; Press, 1972) and is the one reported in this paper. However, MANOVAs were run using all four significance measures, with nearly identical results, therefore providing considerable confidence in

the interpretation of findings. Two-way ANOVAs were also performed to examine main and interaction effects of sex and race on the six cognitive tests individually.

MANOVA results in Table 3 indicate that both sex and race are significantly related to the cognitive tests. Univariate ANOVAs show that race has the

INSERT TABLE 3 ABOUT HERE

strongest and most consistent relationship with cognitive measures. Both sex and race are significantly related to the Stanford-Binet and the WISC Performance IQ, although only race is significantly related to the WISC Full Scale IQ and Verbal IQ.

Generally, blacks score significantly lower than whites on all tests. However, sex differences within race appear on four- and seven-year tests: white females score lower on intelligence tests than white males (although not significantly so), whereas black females score nearly equivalently or slightly higher than black males. The interaction trend approaches significance at the <.1 level for three tests: the Stanford-Binet at four years and the WISC Performance and Full Scale IQs at seven years. Overall, white males score highest on four- and seven-year tests, followed by white females, black females and black males.

The MANOVA results show no overall interaction effect for the dependent measures in linear combination both including or excluding the eight-month tests. Univariate ANOVAs indicate, however, that sex and race interaction trends appear on particular tests. An examination of the standardized

elements of the eigenvectors used to compute the MANOVA (with eight-month tests excluded) indicates that the intelligence tests were weighted in a relative magnitude consistent with univariate ANOVA results. The greatest contribution to the sex by race interaction was made by the WISC Performance IQ, followed by the Stanford-Binet and the WISC Verbal IQ.

Test score differences between the four sex and race groups are shown in Tables 4 and 5. When sexes are analyzed separately (Table 4), MANOVA

INSERT TABLES 4 AND 5 ABOUT HERE

results indicate a significant race effect for females but an even larger effect for males. ANOVA results show that mean differences between black and white males are greater than those between black and white females on each test; however, this difference is particularly apparent for the WISC Performance IQ. An examination of standardized elements of the eigenvectors computed for the MANOVA shows that the Performance IQ is given more weight relative to the Stanford-Binet; considerably less weight is given to the WISC Verbal IQ.

When races are analyzed separately (Table 5), MANOVA results indicate a significant effect of sex for blacks but not for whites, a finding attributable mostly to sample size differences, since whites show larger mean differences than blacks but have a smaller sample. ANOVA results show that significant race differences for females exist only on the WISC IQ tests at age seven, where white females score higher than black females on the WISC Performance and Full Scale IQs and to a lesser extent on the Verbal IQ.

White males score considerably higher than black males on all three WISC IQ scales, as well as the Stanford-Binet. Standardized eigenvectors of the MANOVA show, however, that the WISC Verbal IQ is given more weight, relative to the Stanford-Binet and the Performance IQ. This weighting is not entirely consistent with univariate results however, and may be influenced by an imbalance in sample size.

Sex and Race Correlations in Abilities

Intercorrelations between test scores over time have been used as approximate indicators of the consistency or stability of cognitive processes, as well as a reflection of differences in children's mental growth rates (Bayley and Shaefer, 1964). Evidence that the test scores of females are more highly correlated—i.e., more consistent and stable over time—than the scores of males (Seashore, 1962) can be explained in terms of the earlier maturation of females. In turn, research suggests that early maturation leaves less time for hemispheric lateralization during puberty; thus, females show earlier stabilization of cognitive abilities than males, as reflected by higher test score correlations, but they are less lateralized (Weintraub, 1981).

The extent to which the four sex and race groups in this study differ longitudinally in their rates of cognitive development may be reflected, in part, by the consistency of test score correlations over time. Additionally, intercorrelations between verbal and performance abilities at the same point in time may reflect the extent to which these skills are specialized.

In the following analyses, significant differences in test score consistency for the four sex and race groups were evaluated by comparing differences in

test score correlations at eight months, and four and seven years. The significance of each difference was determined by converting the r's to z's and computing the corresponding critical ratios. As Seashore (1962) notes, this method is an approximate rather than a precise test; we also recognize that four significant differences would be expected by chance alone when comparing 76 pairs of correlations. However, consistent patterns in results reinforce conclusions of between-group differences, particularly for Verbal and Performance tests. Determination of significant differences between the four sex and race groups in verbal and performance abilities at the same point in time was also made by transforming r's to z scores.

1. Longitudinal Differences

Intercorrelations of all six tests for race and sex groups combined (Table 6) show that the eight-month tests correlate least highly with later

INSERT TABLE 6 ABOUT HERE

tests; in turn, the four-year test shows highly significant correlations with all three seven-year tests.

Examination of the correlations between cognitive tests for each sex and race group allows for more specific comparisons (Tables 7 and 8). Overall, no significant differences exist in correlations of the eight-month tests with the four-year test for the four sex by race groups. The exception is a significant difference between black males and females in terms of

INSERT TABLES 7 AND 8 ABOUT HERE

the correlations between the eight-month Bayley Motor and the four-year test; black females show a significantly higher correlation ($z = 2.08$; $p<.05$).

Concerning sex within race differences, females tend to have higher correlations than males between the four-year and the seven-year tests. For black females, both the seven-year WISC Full Scale IQ and the Performance IQ correlate more highly with the four-year test, relative to black males ($z = 3.10$; $p<.05$ and $z = 2.22$; $p<.05$, respectively). For white females relative to white males, the Performance IQ also correlates more highly with the four-year test ($z = 2.09$; $p<.05$). Additionally, the WISC Verbal IQ correlates more highly with the Bayley Motor ($z = 2.40$; $p<.05$).

Concerning race within sex differences, no significant differences exist aside from the higher correlation between the Bayley Motor and the WISC Verbal IQ for white relative to black females ($z = 2.35$; $p<.05$).

2. Seven Year Differences

Comparison of correlations between the WISC Verbal and Performance IQs illuminates possible between-group differences in skill specialization at one time period (Tables 7 and 8).

Clearly, Verbal and Performance tests for black males and black females show nearly identical correlations (r [1392] = .44 and r [1440] = .45, respectively); test correlations for white males and white females, however, are considerably different ($z = 1.97$; $p<.05$). White males show the lowest correlation between Verbal and Performance tests (r [82] = .30), whereas white females show the highest correlation (r [91] = .54). However, correlations of Verbal IQ with Performance IQ did not differ by race within sex

groups. Thus, white males and females show the only significant discrepancy in test correlations relative to the other sex and race groups.

SUMMARY OF RESULTS

Six scales of early cognitive functioning were administered at three times (eight months, four and seven years) to 3013 relatively homogenous, black and white, male and female children. Controlling for selected socio-economic influences, negligible sex or race differences were evident on the eight-month examinations. However, a test score hierarchy existed at the four- and seven-year examinations: white males scored the highest on all tests, followed by white females, black females and black males.

Overall, white females scored somewhat lower than white males on the four- and seven-year tests, whereas black females scored equivalently or somewhat higher than black males. The sex by race interaction trend was most apparent at the four-year test and the seven-year WISC Performance IQ. Moreover, significant mean differences for males within each race were somewhat greater than the mean differences for females. In turn, mean differences for whites within each sex were somewhat greater than those for blacks, although these differences were not reflected in significance levels due to unbalanced sample sizes.

Generally, more consistency existed for females than for males on cognitive tests, as measured by test correlations across times. Concerning age seven verbal and performance tests, black females showed more consistency across time for the WISC Performance IQ only relative to black males; in turn, white females showed more consistency across time for both the WISC

Performance and Verbal IQs relative to white males. Of the four sex and race groups, white females showed the highest correlation between WISC Verbal and Performance IQs at age seven only, whereas white males showed the lowest correlation. Black males and black females showed nearly identical correlations, which ranged between those of white males and females.

DISCUSSION

The primary hypotheses examined in this paper were partially supported: a slight sex by race interaction was found at four and seven years for both verbal and spatial abilities; and sex by race differences were more apparent in seven-year spatial abilities relative to verbal abilities. Specifically, white males showed the highest level of intellectual performance, followed by white females, black females, and black males, in that order. However, sex differences were greater for whites than for blacks, and race differences were greater for males than for females. These results do not corroborate previous studies which showed varying or no sex and race differences in cognitive functioning (Jensen, 1971; Jahoda, 1980; McGlone, 1980; TenHouten, 1980), but they do support other studies which reported similar findings for children and adolescents, as well as for adults (Baughman and Dahlstrom, 1968; Humphreys et al., 1976; Schratz, 1978).

From a longitudinal perspective, females' performance was more stable and consistent than males' performance. These results support earlier findings (Armstrong, 1980; Seashore, 1962; Waber, 1977) which suggested that cognitive abilities among females stabilize earlier than in males.

Previously, however, race differences in cognitive stabilization were not examined. In the present study it was found that among blacks, females showed more stability across time relative to males for spatial performance, whereas among whites, females showed more stability across time than males for both spatial and verbal performance. Thus, it appears that the relative stabilization of verbal and spatial abilities among females varies for the two races. (With one exception, females' verbal performance, no additional race differences in cognitive stabilization were found.)

Patterns of sex and race differences in the stabilization of cognitive abilities correspond to the differential patterns of verbal and spatial abilities shown by the same subjects at age seven. Again, overall race differences were not found. But differential performance on verbal and spatial tasks was apparent for males and females within each race. Among whites, the relationship between verbal and spatial performance was more apparent for females than for males. Among blacks, this relationship was similar for members of both sexes.

Research (Reitan and Davison, 1974) has demonstrated that the relationship between verbal and spatial abilities within subjects indicates patterns of lateral hemispheric specialization. Specifically, differences between these two abilities show hemispheric asymmetries in the processing of verbal and spatial inputs. In the present study, the correlation between the scores obtained in the verbal and spatial tests may be considered an index of asymmetry. The higher the correlation between test scores, the more symmetrical is the hemispheric functioning. Accordingly, the results of the present study showed that hemispheric specialization was more pronounced for

males than for females among whites only. Such differential hemispheric specialization between males and females has been reported before (McGlone, 1980), but with different results among blacks (TenHouten, 1980). Thus, it seems that sex differences in hemispheric specialization may vary across races.

As noted before in the present study, white females in comparison to white males showed both earlier stabilization and more symmetrical hemispheric functioning. It seems, therefore, that both cognitive stabilization and lateralization may be related. Apparently, earlier stabilization facilitates symmetry of hemispheric functioning. In turn, as previous research has suggested, longer maturational development enhances hemispheric specialization (Waber, 1976, 1977). Cognitive stabilization, however, may determine the pattern of hemispheric specialization only when verbal and spatial abilities stabilize simultaneously. As the data on black subjects in the present study showed, differential stabilization in one ability (spatial only) was not reflected in corresponding patterns of hemispheric specialization.

Conflicting approaches exist in the literature for determining sex and race differences in cognitive abilities. These approaches reflect, in part, the basic controversy between biological and environmental explanations for cognitive variation.

The biological approach may be represented by Jensen's (1971) genetic explanation for consistent sex by race differences in general intellectual abilities. In contrast to the findings of the present study, he reported higher scores among both white and black, males and females, with sex

differences greater among blacks than among whites. However, this sex and race pattern has not been generally replicated and may be attributed to a number of potentially confounding environmental factors. For example, Jensen (1971) noted that the direction of a sex by race interaction in many types of abilities varied by the region in which widely different populations were tested. To control for such influences, the present study tested a relatively homogenous group of lower-income subjects who resided in the same urban area (Philadelphia).

The majority of studies, however, use an environmental approach in interpreting sex and race differences in cognitive functioning. Both Baughman and Dahlstrom (1968) and Schratz (1978) found sex by race interactions similar to those reported in this paper for black and white subjects. Assuming similar patterns of maturation for males and females of different ethnic groups, Schratz (1978:263) explained these results in terms of differential environmental influences on cognition. However, as the present and previous studies (e.g., Malina, 1970; Todd, 1931) have shown, maturational rates do vary across different racial groups. Thus Schratz's purely environmental interpretation may be incomplete.

Humphreys et al. (1976) reported some sex by race differences in intellectual abilities similar to those reported in the present study. However, because they found unsystematic differences in performance among subjects of different grades and regions, they dismissed race differences in maturation as a possible explanation for their findings. Instead, they mainly attributed their results to race differences in early sex role socialization. However, because similar sex and race differences were reported in the present study,

where area and grade were the same, it is possible that maturational influences may have some impact on performance.

In light of the conclusion that purely biological or environmental approaches have failed to explain fully sex by race differences in cognitive abilities, it seems that an interactive, sociobiological approach is necessary. For example, in the present study, sex by race discrepancies in the consistency of verbal and spatial abilities across time might be attributed to differential maturational development. In turn, a slight sex by race interaction in verbal and spatial abilities at ages four and seven might be attributed to differential sex role socialization. Support for this explanation comes from Jahoda's (1980) report of similar magnitudes of sex differences in spatial ability among subjects with different sex role socialization, but with similar maturational rates.

Sex and race discrepancies in cognitive functioning therefore seem to be the outcome of rather complex interactive influences of both biological and environmental effects. Delineation of these interactions should constitute a major focus for future research on intellectual development.

TABLE 1: SEVEN YEAR FAMILY INCOME* AND MATERNAL EDUCATION, BY SEX AND RACE

SEX	RACE	N	FAMILY INCOME - CPI INDEX, 1970		MATERNAL EDUCATION (years)	
			Mean Dollars	S.D.	Mean	S.D.
Female	Black	1442	6693	84	10.61	1.67
Male	Black	1394	6694	89	10.69	1.67
Female	White	93	6671	342	9.22	2.66
Male	White	84	7432	334	9.71	2.45

*Family income indicates the 1970 dollar equivalents of the CPP index scores developed for the national CPP sample by Myrianthopoulos and French (1968). CPI dollar amounts predicted for 1980 were slightly more than twice the 1970 dollar amounts (e.g., the 1970 family income of white males is 7432; the 1980 predicted family income is 15,365).

TABLE 2: STANDARD DEVIATIONS FOR SEX AND RACE GROUPS, WITH F-TESTS FOR DIFFERENCES BETWEEN VARIANCES+*

		WHITES						BLACKS					
Age	Tests	Sex	S.D.	F_{11}	p	F_{21}	p	Sex	S.D.	F_{12}	p	F_{22}	p
Eight Months	Bayley Mental	Female Male	3.99 3.99	1.00	n.s.	2.08	.001	Female Male	4.69 5.75	1.50	.01	1.38	.05
	Bayley Motor	Female Male	4.56 4.67	1.05	n.s.	1.12	n.s.	Female Male	4.06 4.42	1.19	n.s.	1.26	.09
Four Years	Stanford Binet	Female Male	13.76 13.00	1.12	n.s.	1.02	n.s.	Female Male	13.10 13.10	1.00	n.s.	1.10	n.s.
Seven Years	Verbal IQ	Female Male	11.77 9.70	1.47	.06	1.31	.09	Female Male	10.85 11.10	1.05	n.s.	1.18	n.s.
	Performance IQ	Female Male	13.84 12.80	1.17	ns.	1.05	n.s.	Female Male	12.16 13.11	1.16	n.s.	1.30	.07
	Full Scale IQ	Female Male	12.32 9.89	1.55	.05	1.29	n.s.	Female Male	10.78 11.22	1.08	n.s.	1.31	.07
		females: n = 93 males : n = 84						females: n = 1442 males : n = 1394					

+F_{11} tests for differences between variances of males and females for whites, and F_{12} tests for blacks.

F_{21} tests for differences between variances of whites and blacks for males, and F_{22} tests for females.

F = larger σ^2/smaller σ^2 with $df_1 = (n_1-1)$ and $df_2 = (n_2-1)$.

*n.s. indicates no significant effect where $p \leq .10$.

TABLE 3: TWO-WAY MANOVA ON COGNITIVE TESTS, BY SEX AND RACE

Age	Tests	Main Effects: Sex (1,3012) p	Main Effects: Sex (1,3012) F	Main Effects: Race (1,3012) p	Main Effects: Race (1,3012) F	Interaction: Sex x Race (1,3012) p	Interaction: Sex x Race (1,3012) F	Mean	S. D.
Eight Months	Bayley Mental	n.s.	(.30)	n.s.	(.31)	n.s.	(.02)	79.6	4.89
	Bayley Motor	.03	(4.54)	.08	(3.14)	n.s.	(.23)	33.4	4.19
Four Years	Stanford Binet	.0006	(12.11)	.0001	(15.73)	.08	(3.07)	94.3	13.11
Seven Years	Verbal IQ	n.s.	(1.77)	.0001	(15.77)	n.s.	(1.42)	90.4	10.93
	Performance IQ	.006	(7.83)	.0001	(37.04)	.07	(3.40)	94.7	12.70
	Full Scale IQ	n.s.	(.30)	.0001	(38.20)	.09	(3.58)	91.7	10.98

	Including Eight Months	Excluding Eight Months
H_0: No overall sex effect	Wilks' L: .9887 p = .0001 F (5, 3005) = 6.87	Wilks' L: .9894 p = .0001 F (3, 3007) = 10.76
H_0: No overall race effect	Wilks' L: .9827 p = .0001 F (5, 3005) = 10.59	Wilks' L: .9866 p = .0001 F (3, 3007) = 13.63
H_0: No overall sex by race interaction	Wilks' L: .9981 p = n.s. F (5, 3005) = 1.16	Wilks' L: .9984 p = n.s. F (3, 3007) = 1.57

* n.s. indicates no significant effect where $p \geq .10$.

TABLE 4: ONE WAY MULTIVARIATE ANALYSIS OF VARIANCE FOR COGNITIVE TESTS, BY RACE, FOR MALES AND FEMALES *

Age	Tests	MALES Race	Mean	Standard Error	Mean Difference	p	FEMALES Race	Mean	Standard Error	Mean Difference	p
Eight Months	Bayley Mental	Black	79.46	.152	-.28	n.s.	Black	79.33	.122	-.57	n.s.
		White	79.74	.619			White	79.90	.482		
	Bayley Motor	Black	33.25	.119	.75	n.s.	Black	33.56	.108	.43	n.s.
		White	32.50	.483			White	33.13	.425		
Four Years	Stanford-Binet	Black	93.10	.351	-5.90	.0001	Black	94.96	.346	-2.33	n.s.
		White	99.00	1.428			White	97.29	1.363		
Seven Years	Verbal IQ	Black	90.44	.295	-4.44	.0001	Black	90.02	.287	-2.41	.04
		White	94.88	1.203			White	92.43	1.131		
	Performance IQ	Black	93.60	.351	-7.88	.0001	Black	95.08	.323	-4.25	.0012
		White	101.48	1.428			White	99.33	1.272		
	Full Scale IQ	Black	91.19	.299	-6.63	.0001	Black	91.67	.286	-3.74	.0014
		White	97.82	1.216			White	95.41	1.128		

H_0: No overall race effect

Including Eight Months

Wilks' L: .9716 p = .0001
F (5, 1472) = 8.61

Excluding Eight Months

Wilks' L: .9769 p = .0001
F (3, 1474) = 11.58

blacks: n = 1394
whites: n = 84

Including Eight Months

Wilks' L: .9906 p = .01
F (5, 1529) = 2.91

Excluding Eight Months

Wilks' L: .9929 p = .01
F (3, 1531) = 3.63

blacks: n = 1442
whites: n = 93

*n.s. indicates no significant effect where $p \geq .10$.

TABLE 5: ONE WAY MULTIVARIATE ANALYSIS OF VARIANCE FOR COGNITIVE TESTS, BY SEX, FOR WHITES AND BLACKS*

		WHITES					BLACKS				
Age	Tests	Sex	Mean	Standard Error	Mean Difference	p	Sex	Mean	Standard Error	Mean Difference	p
Eight Months	Bayley Mental	Female	79.90	.414	.16	n.s.	Female	79.33	.138	-.13	n.s.
		Male	79.74	.436			Male	79.46	.140		
	Bayley Motor	Female	33.13	.476	.63	n.s.	Female	33.56	.112	-.31	.04
		Male	32.50	.503			Male	33.25	.114		
Four Years	Stanford Binet	Female	97.29	1.39	-1.71	n.s.	Female	94.96	.345	1.85	.0002
		Male	99.00	1.46			Male	93.11	.351		
Seven Years	Verbal IQ	Female	92.43	1.13	-2.45	n.s.	Female	90.02	.289	-.42	n.s.
		Male	94.88	1.18			Male	90.44	.294		
	Performance IQ	Female	99.33	1.39	-2.15	n.s.	Female	95.11	.333	1.50	.0018
		Male	101.48	1.46			Male	93.61	.340		
	Full Scale IQ	Female	95.41	1.16	-2.41	n.s.	Female	91.67	.290	.48	n.s.
		Male	97.82	1.23			Male	91.19	.295		

H_0: No overall sex effect

Including Eight Months

Wilks' L: .9764* n.s.
F (5, 171) = .83

Excluding Eight Months

Wilks' L: .9862 n.s.
F (3, 173) = .80

females: n = 93
males: n = 84

Including Eight Months

Wilks' L: .9875 p = .0001
F (5, 2830) = 7.18

Excluding Eight Months

Wilks' L: .9879 p = .0001
F (3, 2832) = 11.51

females: n = 1442
males: n = 1394

*n.s. indicates no significant effect where p ≥ .10.

TABLE 6: CORRELATION MATRIX OF COGNITIVE TESTS, SEXES AND RACES COMBINED

	Eight Months		Four Years	Seven Years		
N = 3013	Bayley Mental	Bayley Motor	Stanford-Binet	Verbal IQ	Perf. IQ	Full Scale IQ
Bayley Mental	1.00					
Bayley Motor	.61**	1.00				
Stanford-Binet	.15**	.20**	1.00			
Verbal IQ	.16**	.13**	.49**	1.00		
Performance IQ	.15**	.15**	.38**	.45**	1.00	
Full Scale IQ	.18**	.16**	.51**	.84**	.86**	1.00
Mean	79.6	33.4	94.3	90.4	94.7	91.7
S.D.	5.2	4.3	13.2	11.0	12.8	11.1
Minimum	7	3	44	50	47	48
Maximum	90	43	152	135	142	130

**p ≤ .0001
*p ≤ .05

TABLE 7: CORRELATION MATRIX OF COGNITIVE TESTS, FOR WHITE MALES AND FEMALES

		Eight Months		Four Years	Seven Years		
		Bayley Mental	Bayley Motor	Stanford-Binet	Verbal IQ	Perf. IQ	Full Scale IQ
Eight Months	Bayley Mental	FEMALES	$.63^{***}$	.09	.15	.15	.19 FEMALES
	Bayley Motor	$.53^{***}$		.08	.03	$.23^{*}$	.17
Four Years	Stanford-Binet	$.21^{*}$	$.35^{**}$		$.48^{***}$	$.22^{*}$	$.42^{***}$
Seven Years	Verbal IQ	$.22^{*}$	$.38^{**}$	$.56^{***}$		$.30^{**}$	$.77^{***}$
	Performance IQ	.06	.14	$.49^{***}$	$.54^{***}$		$.84^{***}$
	Full Scale IQ	.16 MALES	$.29^{**}$	$.60^{***}$	$.87^{***}$	$.88^{***}$ MALES	

$^{***}p \leq .0001$
$^{**}p \leq .01$
$^{*}p \leq .05$

females - upper triangle
males - lower triangle

TABLE 8: CORRELATION MATRIX OF COGNITIVE TESTS, FOR BLACK MALES AND FEMALES

		Eight Months		Four Years	Seven Years		
	Tests	Bayley Mental	Bayley Mental	Stanford-Binet	Verbal IQ	Perf. IQ	Full Scale IQ
		FEMALES					FEMALES
Eight Months	Bayley Mental		.59***	.16***	.17***	.16***	.19***
	Bayley Motor	.64***		.24***	.14***	.18***	.19***
Four Years	Stanford-Binet	.13***	.17***		.49***	.42***	.53***
Seven Years	Verbal IQ	.15***	.13***	.48***		.45***	.85***
	Performance IQ	.14***	.12***	.32***	.44**		.85***
	Full Scale IQ	.16***	.15***	.47***	.84***	.86***	
		MALES					MALES

***p ≤ .0001
**p ≤ .01
*p ≤ .05

females - upper triangle
males - lower triangle

REFERENCES

Anastasi, A. Differential Psychology: Individual and Group Differences In Behavior. New York: Macmillan Co, 1958.

Armstrong, D. F. Relationships Between Biological and Mental Development at Adolescence. Ph.D. dissertation, University of Pennsylvania, 1980.

Baughman, E. E. and Dahlstrom, W. G. Negro and White Children: A Psychological Study in the Rural South. New York: Academic Press, 1968

Bayley, N. "Mental growth during the first three years: A developmental study of sixty-one children by repeated tests." Genetic Psychology Monographs, 1933, 14: 1-92.

Bayley, N. and Schaefer, E. S. "Correlations of maternal and child behavior with development of mental abilities." Monograph of the Society on Research in Child Development, 1964, 29 (6).

Benbow, C. P. and Stanley, J. C. "Sex differences in mathematical ability: fact or artifact?" Science, 1980, 210 (12): 1262-1264.

Bock, R. D. and Kolakowski, D. "Further evidence of sex-linked major-gene influence on human spatial visualizing ability." American Journal of Human Genetics, 1973, 25: 1-14.

Bogen, J. E. "The other side of the brain II: an appositional mind." Bulletin of the Los Angeles Neurological Societies, 1969, 37: 49-61.

Broman, S. H.; Nichols, P. L. and Kennedy, W. A. Preschool IQ: Prenatal and Early Developmental Correlates. New York: John Wiley and Sons, 1975.

Broverman, D. M.; Klaiber, E. L.; Kobayashi, Y. and Vogel, W. "Roles of activation and inhibition in sex differences in cognitive abilities." Psychological Review, 1968, 75: 23-50.

Bryden, M. P. "Evidence for sex-related differences in cerebral organization." In M. Wittig and A. C. Petersen (Eds.), Sex-Related Differences in Cognitive Functioning. New York: Academic Press, 1979.

Burstein, B.; Bank, L. and Jarvik, L. F. "Sex differences in cognitive functioning: evidence, determinants, implications." Human Development, 1980, 23: 289-313.

Eveleth, P. B.; Bowers, E. J. and Schall, J. I. "Secular change in growth of Philadelphia black adolescents." Human Biology, 1979, 51 (2): 213-228.

Goffeney, B.; Henderson, N. B. and Butler, B. V. "Negro-white, male-female eight-month developmental scores compared with seven-year WISC and Bender test scores." Child Development, 42: 595-604.

Green, P. E. Analyzing Multivariate Data. Hinsdale: The Dryden Press. 1978.

Harris, L. J. "Sex differences in spatial ability: possible environmental, genetic, and neurological factors." In M. Kinsbourne (Ed.), Asymmetrical Function of the Brain. London: Cambridge University Press, 1978.

Harshman, R. A. "Sex, language, and the brain: adult sex differences in lateralization." In D. O. Walter; L. Rogers and J. M. Finzi-Fried (Eds.), Conference on Human Brain Function: Brain Information Service. Los Angeles: Publication Office, UCLA, 1976.

Hetherington, E. M. "A developmental study of the effects of sex of one dominant parent on sex role preferences, identification and imitation in children." Journal of Personality and Social Psychology, 1965, 2: 188-194.

Hoyenga, K. B. and Hoyenga, K. T. The Question of Sex Differences. Boston: Little, Brown, 1979.

Humphreys, L. G.; Lin, P. G. and Fleishman, A. "The sex x race interaction in cognitive measures." Journal of Research in Personality, 1976, 10: 42-58.

Jahoda, G. "Sex and ethnic differences on a spatial-perceptual task: Some hypotheses tested." British Journal of Psychology, 1980, 71: 425-431.

Jensen, A. R. "The race x sex x ability interaction." In R. Cancro (Ed.), Intelligence: Genetic and Environmental Influence. New York: Grune and Stratton.

Kamin, L. J. "Sex differences in susceptibility of IQ to environmental influence." Child Development, 1978, 49: 517-518.

Kimura, D. "Spatial location in left and right visual fields." Canadian Journal of Psychology, 1969, 23: 445-458.

Levy, J. "Cerebral lateralization and spatial ability." Behavior Genetics, 1976, 72: 117-128.

Levy, J. and Gur, R. C. "Individual differences in psychoneurological organization." In J. Herron (Ed.) Neuropsychology of Left-Handedness. New York: Academic Press, 1980.

Levy, J. and Reid, M. "Variations in writing posture and cerebral dominance." Science, 1976, 194: 337-339.

Maccoby, E. E.; Doering, C. H.; Jacklin, C. N. and Draemer, H. "Concentrations of sex hormones in umbilical cord-blood: their relations to sex and birth order of infants." Child Development, 1979, 50: 632-642.

Maccoby, E. E. and Jacklin, C. N. The Psychology of Sex Differences. Stanford: Stanford University Press, 1974.

Malina, R. M. "Skeletal maturation studied longitudinally over one year in American whites and Negroes six through thirteen years of age." Human Biology, 1970, 42: 377-390.

Money, J.; Ehrahardt, A. A. and Masica, D. N. "Fetal feminization induced by androgen insensitivity in the testicular feminizing syndrome. Effect on marriage and maternalism." Johns Hopkins Medical Journal, 1968, 123: 105-114.

Mussen, P. H. "Early sex role development." In, D. A. Goslin (Ed.), Handbook of Socialization Theory and Research. Chicago: Rand McNally, 1969.

Myrianthopoulos, N. C. and French, K. S. "An application of the U.S. Bureau of the Census socioeconomic index to a large, diversified, patient population." Social Science and Medicine, 1968, 2: 283-299.

McGee, M. "Human spatial abilities: psychometric studies and environmental, genetic, hormonal, and neurological influences." Psychological Bulletin, 1979, 86: 889-918.

McGlone, J. "Sex differences in human brain asymmetry: a critical survey." The Behavioral and Brain Sciences, 1980, 3: 215-263.

McGuinness, D.and Pribram, K. H. "The origin of sensory bias in the development of gender differences in perception and cognition." In M. Bortner (Ed.), Cognitive Growth and Development. New York: Brunner/Mazel, 1979.

Nachshon, I. "Brain, language and culture: cross-cultural differences in laterality." Unpublished manuscript, 1981.

Nachshon, I.; Denno, D. and Aurand, S. "Lateral Preferences of Hand, Eye, and Foot: Relation to Cerebral Dominance." Unpublished manuscript, 1981.

Nottebohm, F. "A continuum of sexes bedevils the search for sexual differences?" The Behavioral and Brain Sciences, 1980, 3: 245-246.

Park, J.; Johnson, R. C.; DeFries, J. C.; McClearn, G. E.; Mi, M. P.; Rashad, M. N.; Vandenbert, S. G. and Wilson, J. R. "Parent-Offspring resemblance for specific cognitive abilities in Korea." Behavior Genetics, 1978, 8 (1): 43-52.

Pedersen, F. A.; Rubenstein, J. L. and Yarrow, L. J. "Infant development in father-absent families." The Journal of Genetic Psychology, 1979, 135: 51-61.

Press, S. J. Applied Multivariate Analysis. New York: Holt, Rinehart and Winston, Inc., 1972.

Ray, W. J. and Newcombe, N. "Interpreting sex differences in lateralization." The Behavioral and Brain Sciences, 1980, 3: 246.

Reitan, R.M. and Davison, L.A. Clinical Neuropsychology: Current Status and Applications. New York: John Wiley and Sons, 1974.

Schratz, M. M. "A developmental investigation of sex differences in spatial (visual-analytic) and mathematical skills in three ethnic groups." Developmental Psychology, 1978, 14 (3): 263-267.

Seashore, H. G. "Women are more predictable than men." Journal of Counseling Psychology, 1962, 9 (3): 261-270.

Serpell, R. "How specific are perceptual skills? A cross-cultural study of pattern reproduction." British Journal of Psychology, 1979, 70: 365-380.

Sherman, J. A. Sex-Related Cognitive Differences. Springfield: Charles C. Thomas, 1978.

Silverstein, A. B. "The internal consistency of the Stanford-Binet." American Journal of Mental Deficiency, 1969, 73: 753-754.

Silverstein, A. B. "Validity of WISC short forms at three age levels." Journal of Consulting Psychology, 1967, 31: 635-636.

Strauch, A. B. "More on the sex x race interaction on cognitive measures." Journal of Educational Psychology, 1977, 69 (2): 152-157.

TenHouten, W. D. "Social dominance and cerebral hemisphericity: discriminating race, socioeconomic status, and sex groups by performance on two lateralized tests." International Journal of Neuroscience, 1980, 10: 223-232.

Thompson, A. L.; Bogen, J. E. and Marsh, J. F. "Cultural hemisphericity: evidence from cognitive tests." International Journal of Neuroscience, 1979, 9: 37-43.

Todd, T. W. "Differential skeletal maturation in relation to sex, race, variability and disease." Child Development, 1931, 2: 49-65.

Waber, D. P. "Sex differences in cognition: a function of maturation rate?" Science, 1976, 192: 572-574.

Waber, D. P. "Sex differences in mental abilities, hemispheric lateralization, and rate of physical growth at adolescence." Developmental Psychology, 1977, 13 (1): 29-38.

Wechsler, D. The Measurement of Adult Intelligence. Baltimore: Williams and Wilkins, 1944.

Wechsler, D. Wechsler Intelligence Scale for Children. New York: Psychological Corporation, 1949.

Weintraub, P. "The brain: his and hers." Discover: The News Magazine of Science, 1981, 2 (4): 14-20.

Wildt, A. R. and Ahtola, O. T. Analysis of Covariance. Beverly Hills: Sage Publications, 1978.

Wolfe, J. The Impact of Parental Resources on Childhood IQ. Ph.D. dissertation, University of Pennsylvania.